In The Claims:

1.- 43. (Cancelled)

44. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer having a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice; and

a pinned magnetic layer ~~formed~~ in contact with said first region of said antiferromagnetic layer such that an exchange coupling magnetic field is produced at ~~the~~ an interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic layer is transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which a ratio of an atomic percent of said element X to Mn increases in a direction towards said pinned magnetic layer; and

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice;

a free magnetic layer;

a non-magnetic intermediate layer ~~formed~~ between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

a bias layer which aligns the direction of magnetization of said free magnetic layer in a direction intersecting the direction of magnetization of said pinned magnetic layer~~;~~

~~wherein said antiferromagnetic layer and said pinned magnetic layer in contact with said antiferromagnetic layer are formed of the exchange coupling film~~

~~as claims in Claim 1~~.

45. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer having a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice; ~~and~~

a pinned magnetic layer formed in contact with said first region of said antiferromagnetic layer such that an exchange coupling magnetic field is produced at ~~the~~ an interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X, an element X' and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, wherein the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic layer is transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in a direction towards said pinned magnetic layer;

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice;

a free magnetic layer;

a non-magnetic intermediate layer ~~formed~~ between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

a bias layer which aligns the direction of magnetization of said free magnetic layer in a direction intersecting the direction of magnetization of said pinned

magnetic layer~~;~~

~~wherein said antiferromagnetic layer and said pinned magnetic layer in contact with said antiferromagnetic layer are formed of the exchange coupling film as claims in Claim 2~~.

46. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer; and

a pinned magnetic layer ~~formed~~ in contact with said antiferromagnetic layer such that an exchange coupling magnetic field is produced at the interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

a free magnetic layer having an upper side and a lower side;

a non-magnetic intermediate layer ~~formed~~ between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

an antiferromagnetic exchange bias layer ~~formed either at~~ adjacent to one of the upper side or the lower side of said free magnetic layer and having portions spaced from each other in the track width direction and said portions having a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic exchange bias layer comprises an antiferromagnetic material containing an element X and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic exchange bias layer is transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic exchange bias layer includes a region in which a ratio of an atomic percent of said element X to Mn increases in a direction towards said free magnetic layer; and

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic exchange bias layer has a CuAu-I type face-centered square

ordered lattice, and

~~wherein said exchange bias layer and said free magnetic layer are formed of the exchange coupling film as claims in Claim 1; and~~

wherein the magnetization of said free magnetic layer is fixed in a predetermined direction.

47. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer; and

a pinned magnetic layer ~~formed~~ in contact with said antiferromagnetic layer such that an exchange coupling magnetic field is produced at the interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

a free magnetic layer having an upper side and a lower side;

a non-magnetic intermediate layer ~~formed~~ between said pinned magnetic layer and a free magnetic layer; and

an antiferromagnetic exchange bias layer ~~formed either at~~ adjacent to one of the upper side or the lower side of said free magnetic layer and having portions spaced from each other in the track width direction, said portions having a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic exchange bias layer layer comprises an antiferromagnetic material containing an element X, an element X' and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, wherein the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic exchange bias layer layer is transformed by an annealing process to an annealed antiferromagnetic exchange bias layer layer,

wherein said annealed antiferromagnetic exchange bias layer layer includes a

region in which the ratio of the atomic percent of the elements X + X' to Mn increases in a direction towards said free layer;

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic exchange bias layer layer has a CuAu-I type face-centered square ordered lattice, and

~~wherein said exchange bias layer and said free magnetic layer are formed of the exchange coupling film as claims in Claim 2; and~~

wherein the magnetization of said free magnetic layer is fixed in a predetermined direction.

48. (Currently amended) A magnetoresistive sensor comprising:

a free magnetic layer having an upper side and a lower side;

first and second non-magnetic intermediate layers ~~formed~~ on the upper and lower sides, respectively, of said free magnetic layer;

first and second pinned magnetic layers ~~one of which~~ wherein the first pinned magnetic layer is ~~formed~~ on the upper side ~~of one~~ of the first non-magnetic intermediate layer ~~layers while the other~~ and the second pinned magnetic layer is on the lower side ~~of the other~~ of the second non-magnetic intermediate layer ~~layers~~;

first and second antiferromagnetic layers ~~one of which~~ wherein the first antiferromagnetic layer is ~~formed~~ on the upper side ~~of the one~~ of the first pinned magnetic layer ~~layers~~ ~~while the other~~ and the second pinned magnetic layer on the lower side ~~of the othe~~r of the second pinned magnetic layer ~~layers, the antiferromagnetic layers serving to fix the directions of magnetization of the associated pinned magnetic layers by exchange anisotropic magnetic fields~~; and

a bias layer which aligns the direction of magnetization of the free magnetic layer to a direction that intersects the directions of the first and second pinned magnetic layers;

wherein at least one of the first and second antiferromagnetic layers has a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice; and

wherein at least one of the first and second pinned magnetic layers is in contact with said first region of said antiferromagnetic layer, such that an exchange coupling magnetic field is produced at an interface between said antiferromagnetic layer and said pinned magnetic layer that fixes the magnetization of said ferromagnetic layer in a predetermined direction,

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic layer is transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which a ratio of an atomic percent of said element X to Mn increases in a direction towards said pinned magnetic layer; and

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein the antiferromagnetic layer and the pinned magnetic layer contacting therewith, at at least one of the upper and lower sides of said free magnetic layer, are formed of the exchange coupling film as claimed in Claim 1~~.

49. (Currently amended) A magnetoresistive sensor comprising:

a free magnetic layer having an upper side and a lower side;

first and second non-magnetic intermediate layers formed on the upper and lower sides, respectively, of said free magnetic layer;

first and second pinned magnetic layers ~~one of which~~ wherein the first pinned magnetic layer is ~~formed~~ on the upper side ~~of one~~ of the first non-magnetic intermediate layer ~~layers while the other~~ and the second pinned magnetic layer is on the lower side ~~of the other~~ of the second non-magnetic intermediate layer ~~layers~~;

first and second antiferromagnetic layers ~~one of which~~ , wherein the first antiferromagnetic layer is ~~formed~~ on the upper side ~~of the one~~ of the first pinned magnetic layer ~~layers~~ ~~while the other~~ and the second pinned magnetic layer on the

lower side ~~of the othe~~r of the second pinned magnetic layer ~~layers, the antiferromagnetic layers serving to fix the directions of magnetization of the associated pinned magnetic layers by exchange anisotropic magnetic fields~~; and

a bias layer which aligns the direction of magnetization of the free magnetic layer to a direction that intersects the directions of the pinned magnetic layers;

wherein at least one of the first and second antiferromagnetic layers has a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice; and

wherein at least one of said first and second pinned magnetic layers is in contact with said first region of said antiferromagnetic layer such that an exchange coupling magnetic field is produced at an interface between said antiferromagnetic layer and said ferromagnetic layer to fix the magnetization of said ferromagnetic layer in a predetermined direction,

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X, an element X' and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, wherein the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic layer is transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in a direction towards said ferromagnetic layer; and

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein the antiferromagnetic layer and the pinned magnetic layer contacting therewith, at at least one of the upper and lower sides of said free magnetic layer, are formed of the exchange coupling film as claimed in Claim 2~~.

50. (Currently amended) A magnetoresistive sensor comprising:

a non-magnetic layer;

a magnetoresistive layer having an upper side and a lower side and a soft magnetic layer which are superposed through the intermediary of said non-magnetic layer; and

an antiferromagnetic layer ~~formed on~~ adjacent to one of the upper side or the lower side of the magnetoresistive layer and having portions spaced from each other in the track width direction, said portions having a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice;

wherein said magnetoresistive layer is in contact with said first region of said antiferromagnetic layer, such that an exchange coupling magnetic field is produced at an interface between said antiferromagnetic layer and said magnetoresistive layer that fixes the magnetization of said magnetoresistive layer in a predetermined direction,

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic layer is transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which a ratio of an atomic percent of said element X to Mn increases in a direction towards said magnetoresistive layer; and

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein said antiferromagnetic layer and said magnetoresistive layer and said magnetoresistive layer are formed of the exchange coupling film as claimed in Claim 1~~.

51. (Currently amended) A magnetoresistive sensor comprising:

a non-magnetic layer;

a magnetoresistive layer having an upper side and a lower side and a soft magnetic layer which are superposed through the intermediary of said non-magnetic layer; and

an antiferromagnetic layer ~~formed on~~ adjacent to one of the upper side or the lower side of the magnetoresistive layer and having portions spaced from each other in the track width direction, said portions having a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic layer layer comprises an antiferromagnetic material containing an element X, an element X' and Mn, wherein said element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, wherein the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic layer layer is transformed by an annealing process to an annealed antiferromagnetic exchange bias layer layer,

wherein said annealed antiferromagnetic exchange bias layer layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in a direction towards said magnetoresistive layer;

wherein a crystalline structure of at least a portion of said annealed antiferromagnetic layer layer has a CuAu-I type face-centered square ordered lattice ~~wherein said antiferromagnetic layer and said magnetoresistive layer and said magnetoresistive layer are formed of the exchange coupling film as claimed in Claim 2~~.

52. – 100. (Cancelled)

101. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer having a first region and a second region configured to create a non-aligned crystal lattice state and a third region intermediate to the first and second regions that is configured to transform from a disordered lattice to an ordered lattice; and

a pinned magnetic layer formed in contact with said antiferromagnetic layer such that an exchange coupling magnetic field is produced at the interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic layer is configured to be transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the element X to Mn increases towards said pinned magnetic layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the element X to Mn increases in the direction away from said pinned magnetic layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice;

a free magnetic layer;

a non-magnetic intermediate layer formed between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

a bias layer which aligns the direction of magnetization of said free magnetic layer in a direction intersecting the direction of magnetization of said pinned magnetic layer~~;~~

~~wherein said antiferromagnetic layer and said pinned magnetic layer in contact with said antiferromagnetic layer are formed of the exchange coupling film as claims in Claim 52~~.

102. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer having a first region and a second region configured to create a non-aligned crystal lattice state and a third region intermediate to the first and second regions that is configured to transform from a disordered lattice to an ordered lattice; and

a pinned magnetic layer formed in contact with said antiferromagnetic layer such that an exchange coupling magnetic field is produced at the interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X, an element X', and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, while the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic layer is configured to be transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases towards said pinned magnetic layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in the direction away from said pinned magnetic layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice;

a free magnetic layer;

a non-magnetic intermediate layer formed between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

a bias layer which aligns the direction of magnetization of said free magnetic layer in a direction intersecting the direction of magnetization of said pinned magnetic layer~~;~~

~~wherein said antiferromagnetic layer and said pinned magnetic layer in contact with said antiferromagnetic layer are formed of the exchange coupling film as claims in Claim 53~~.

103. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer; and

a pinned magnetic layer formed in contact with said antiferromagnetic layer such that an exchange coupling magnetic field is produced at the interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

a free magnetic layer having an upper side and a lower side;

a non-magnetic intermediate layer formed between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

an antiferromagnetic exchange bias layer ~~formed either a~~t adjacent to one of the upper side or the lower side of said free magnetic layer and having portions spaced from each other in the track width direction, the portions having a first region and a second region configured to create a non-aligned crystal lattice state and a third region intermediate to the first and second regions that is configured to transform from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic exchange bias layer comprises an antiferromagnetic material containing an element X and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic exchange bias layer is configured to be transformed by an annealing process to an annealed antiferromagnetic exchange bias layer,

wherein said annealed antiferromagnetic exchange bias layer includes a

region in which the ratio of the atomic percent of the element X to Mn increases towards said free magnetic layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the element X to Mn increases in the direction away from said free magnetic layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice ~~wherein said exchange bias layer and said free magnetic layer are formed of the exchange coupling film as claims in Claim 52~~.

104. (Currently amended) A magnetoresistive sensor comprising:

an antiferromagnetic layer; and

a pinned magnetic layer formed in contact with said antiferromagnetic layer such that an exchange coupling magnetic field is produced at the interface between said antiferromagnetic layer and said pinned magnetic layer to fix the magnetization of said pinned magnetic layer in a predetermined direction;

a free magnetic layer;

a non-magnetic intermediate layer formed between said pinned magnetic layer and ~~a~~ said free magnetic layer; and

an antiferromagnetic exchange bias layer ~~formed either at~~ adjacent to one of the upper side or the lower side of said free magnetic layer and having portions spaced from each other in the track width direction, the portions having a first region and a second region configured to create a non-aligned crystal lattice state and a third region intermediate to the first and second regions that is configured to transform from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic exchange bias layer comprises an antiferromagnetic material containing an element X, an element X', and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, while the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni,

Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic exchange bias layer magnetic layer is transformed by an annealing process to an annealed antiferromagnetic exchange bias layer,

wherein said annealed antiferromagnetic exchange bias layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases towards said free magnetic layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in the direction away from said free magnetic layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein said exchange bias layer and said free magnetic layer are formed of the exchange coupling film as claims in Claim 53~~.

105. (Currently amended) A magnetoresistive sensor comprising:

a free magnetic layer having an upper side and a lower side;

first and second non-magnetic intermediate layers formed on upper and lower sides, respectively, of said free magnetic layer;

first and second pinned magnetic layers ~~one of which~~ wherein the first pinned magnetic layer is ~~formed~~ on the upper side ~~of one~~ of the first non-magnetic intermediate layer ~~layers while the other~~ and the second pinned magnetic layer is on the lower side ~~of the other~~ of the second non-magnetic intermediate layer ~~layers~~;

first and second antiferromagnetic layers ~~one of which~~ wherein the first antiferromagnetic layer is ~~formed~~ on the upper side ~~of the one~~ of the first pinned magnetic layer ~~layers while the other~~ and the second pinned magnetic layer on the lower side ~~of the other~~ of the second pinned magnetic layer ~~layers~~, ~~the antiferromagnetic layers serving to fix the directions of magnetization of the associated pinned magnetic layers by exchange anisotropic magnetic fields~~; and

a bias layer which aligns the direction of magnetization of the free magn1etic layer to a direction that intersects the directions of the first and second pinned magnetic layers;

wherein at least one of the first and second antiferromagnetic layers has a first region configured to create a non-aligned crystal lattice state and a second region configured to transform from a disordered lattice to an ordered lattice; and

wherein at least one of the first and second pinned magnetic layers is in contact with said first region of said antiferromagnetic layer, such that an exchange coupling magnetic field is produced at an interface between said antiferromagnetic layer and said pinned magnetic layer that fixes the magnetization of said pinned layer in a predetermined direction,

wherein said at least one antiferromagnetic layer comprises an antiferromagnetic material containing an element X and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic layer is configured to be transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the element X to Mn increases towards said ferromagnetic layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the element X to Mn increases in the direction away from said ferromagnetic layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein the antiferromagnetic layer and the pinned magnetic layer contacting therewith, at at least one of the upper and lower sides of said free magnetic layer, are formed of the exchange coupling film as claimed in Claim 52~~.

106. A magnetoresistive sensor comprising:

a free magnetic layer having an upper side and a lower side;

first and second non-magnetic intermediate layers formed on upper and lower sides, respectively, of said free magnetic layer;

first and second pinned magnetic layers ~~one of which~~ wherein the first pinned magnetic layer is ~~formed~~ on the upper side ~~of one~~ of the first non-magnetic intermediate layer ~~layers while the other~~ and the second pinned magnetic layer is on the lower side ~~of the other~~ of the second non-magnetic intermediate layer ~~layers~~;

first and second antiferromagnetic layers ~~one of which~~ wherein the first antiferromagnetic layer is ~~formed~~ on the upper side ~~of the one~~ of the first pinned magnetic layer ~~layers while the other~~ and the second pinned magnetic layer on the lower side ~~of the other~~ of the second pinned magnetic layer ~~layers, the antiferromagnetic layers serving to fix the directions of magnetization of the associated pinned magnetic layers by exchange anisotropic magnetic fields~~; and

a bias layer which aligns the direction of magnetization of the free magnetic layer to a direction that intersects the directions of the first and second pinned magnetic layers;

wherein at least one of the first and second said antiferromagnetic layers comprises an antiferromagnetic material containing an element X, an element X', and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, while the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said at least one antiferromagnetic layer is configured to be transformed by an annealing process to an annealed antiferromagnetic layer, wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases towards said pinned magnetic layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in the direction away from said pinned magnetic layer starting from said thicknesswise central

region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice.

~~wherein the antiferromagnetic layer and the pinned magnetic layer contacting therewith, at at least one of the upper and lower sides of said free magnetic layer, are formed of the exchange coupling film as claimed in Claim 53~~.

107. (Currently amended) A magnetoresistive sensor comprising:

a non-magnetic layer having an upper side and a lower side;

a magnetoresistive layer and a soft magnetic layer which are superposed through the intermediary of said non-magnetic layer; and

an antiferromagnetic layer ~~formed on~~ adjacent to one of the upper side or the lower side of the magnetoresistive layer and having portions spaced from each other in the track width direction, said antiferromagnetic layer having a first region and a second region configured to create a non-aligned crystal lattice state and a third region intermediate to the first and second regions that is configured to transform from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof;

wherein said antiferromagnetic layer is configured to be transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the element X to Mn increases towards said magnetoresistive layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the element X to Mn increases in the direction away from said magnetoresistive layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein said antiferromagnetic layer and said magnetoresistive layer and said magnetoresistive layer are formed of the exchange coupling film as claimed in Claim 52~~.

108. (Currently amended) A magnetoresistive sensor comprising:

a non-magnetic layer having an upper side and a lower side;

a magnetoresistive layer and a soft magnetic layer which are superposed through the intermediary of said non-magnetic layer; and

an antiferromagnetic layer ~~formed on~~ adjacent to one of the upper side or the lower side of the magnetoresistive layer and having portions spaced from each other in the track width direction, said antiferromagnetic layer having a first region and a second region configured to create a non-aligned crystal lattice state and a third region intermediate to the first and second regions that is transformed from a disordered lattice to an ordered lattice;

wherein said antiferromagnetic layer comprises an antiferromagnetic material containing an element X, an element X', and Mn, where the element X is selected from the group of elements consisting of Pt, Pd, Ir, Rh, Ru, and Os, and combinations thereof, while the element X' is selected from the group of elements consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb and a rare earth element and combinations thereof;

wherein said antiferromagnetic layer is configured to be transformed by an annealing process to an annealed antiferromagnetic layer,

wherein said annealed antiferromagnetic layer includes a region in which the ratio of the atomic percent of the elements X + X' to Mn increases towards said magnetoresistive layer starting from a thicknesswise central region and a region in which the ratio of the atomic percent of the elements X + X' to Mn increases in the direction away from said magnetoresistive layer starting from said thicknesswise central region; and

wherein the crystalline structure of at least part of said annealed

antiferromagnetic layer has a CuAu-I type face-centered square ordered lattice

~~wherein said antiferromagnetic layer and said magnetoresistive layer and said magnetoresistive layer are formed of the exchange coupling film as claimed in Claim 53~~.

109. (New) An exchange coupling film according to Claim 44, wherein said antiferromagnetic layer has a lattice constant and said ferromagnetic layer has a lattice constant and wherein said lattice constants of said antiferromagnetic layer and said ferromagnetic layer have different values over at least part of said interface.

110. (New) An exchange coupling film according to Claim 44, wherein said antiferromagnetic layer has a crystalline orientation and said ferromagnetic layer has a crystalline orientation and wherein said crystalline orientations of said antiferromagnetic layer and said ferromagnetic layer differ over at least part of said interface.

111. (New) An exchange coupling film according to one of Claims 44, wherein a non-aligned crystal lattice state exists over at least part of said interface.

112. (New) An exchange coupling film according to Claim 44, wherein an imaginary boundary within a thickness of said annealed antiferromagnetic layer resides in parallel with said interface so as to divide said annealed antiferromagnetic layer into a first region between said imaginary boundary and said interface and a second region between said imaginary boundary and a face surface of said annealed antiferromagnetic layer opposite to said interface, and wherein said annealed antiferromagnetic has a region in which said ratio increases from said second region in a direction towards said first region across said imaginary boundary.

113. (New) An exchange coupling film according to Claim 45, wherein said antiferromagnetic material comprises one of an interstitial solid solution in which the element X' has invaded the interstices of a space lattice constituted by the element X and Mn, or a substitutive solid solution in which a portion of the lattice points of a crystal lattice constituted by said element X and Mn is substituted by said element X'.

114. (New) An exchange coupling film according to Claim 45, wherein said antiferromagnetic layer has a lattice constant and said ferromagnetic layer has a lattice constant and wherein said lattice constants of said antiferromagnetic layer and said ferromagnetic layer have different values over at least part of said interface.

115. (New) An exchange coupling film according to Claim 45, wherein said antiferromagnetic layer has a crystalline orientation and said ferromagnetic layer has a crystalline orientation and wherein said crystalline orientations of said antiferromagnetic layer and said ferromagnetic layer differ over at least part of said interface.

116. (New) An exchange coupling film according to one of Claims 45, wherein a non-aligned crystal lattice state exists over at least part of said interface.

117. (New) An exchange coupling film according to Claim 45, wherein an imaginary boundary within a thickness of said annealed antiferromagnetic layer resides in parallel with said interface so as to divide said annealed antiferromagnetic layer into a first region between said imaginary boundary and said interface and a second region between said imaginary boundary and a face surface of said annealed antiferromagnetic layer opposite to said interface, and wherein said annealed antiferromagnetic layer has a region in which said ratio increases from said second region in a direction towards said first region across said imaginary boundary.